Mountain Safety Research – WaterWorks™ EX Microfilter

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Device Information

The Mountain Safety Research (MSR) WaterWorks™ EX Microfilter is a handheld pump water treatment device utilizing ceramic microfiltration and second stage membrane microfiltration. This device is identical to the MSR MiniWorks™ EX except for the second stage filter, making the device slightly larger and heavier. At the heart of the device is what the manufacturer calls the "Marathon EX Ceramic Element", a 0.3 µm nominal ceramic depth filter with carbon block core. The second stage manufacturer termed "PES" filter cartridge consists of a pleated polyethersulfone membrane microfilter rated at 0.2 µm absolute. This device is designed for bacteria, cyst, and taste and odor reduction, but contains no reduction mechanism for virus. The manufacturer recommends a chemical disinfectant be added for treating virus. The device consists of a plastic housing, ceramic and carbon filter element, membrane microfilter, inlet tubing, tubing weight and float, and foam pre-filter. Additionally, the device comes with a filter element scrubbing pad, ceramic element measuring gauge, and storage bag. The tubing weight and float work to keep the inlet tubing submerged, yet off of the bottom of the raw water source to limit the introduction of sediment. The bottom of the pump housing contains threads for direct connection to MSR Dromedary™ bags and wide mouth (e.g., Nalgene®) bottles. The device can also be held above any collection container to collect product water. The device utilizes what the manufacturer calls an "airspring accumulator", which traps an air bubble in the filter housing. The air bubble compresses on the down stroke then expands on the up stoke, pushing water through the cartridge without additional operator input. This device creates an absolute barrier to contaminants greater than the pore size and may remove taste and odor through carbon filtration. This device contains no chemicals and requires no wait time. No discarding of initial product water is recommended by the manufacturer. Before initial use, and after extended non-use, the airspring accumulator must be primed by pumping a small amount of water then air through the filter to trap the air bubble. This device is fully field-serviceable, and can be disassembled without tools. For optimal use the manufacturer recommends a pumping rate of 70-80 strokes per minute.

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Effectiveness Against Microbial Pathogens

No results were received specific to testing the MSR WaterWorks EX. Since this device is identical to the MSR MiniWork EX except for an additional second stage microfilter, testing results for the MiniWorks can be assumed to apply to this device. Pathogen reductions are expected to meet or exceed those shown for the MiniWorks. No results were obtained that challenged either device strict to the requirements of the USEPA Guide Standard and Protocol for Testing Microbiological Water Purifiers (reference 1). Results from independent laboratory studies (references 2 and 3) were reviewed that challenged the MSR MiniWorks against modified versions of reference 1. Under this modified protocol, data showed that this device is capable of meeting the log reduction requirements for bacteria and *Cryptosporidium* oocysts as stated in reference 3 and shown in the table below. Since size exclusion is the reduction mechanism, observed virus reduction (reference 2) was minimal and did not meet the requirements of reference 1. Due to the larger size of *Giardia* in comparison to *Cryptosporidium*, adequate log reduction is assumed. During the testing of reference 2 the flowrate was set at 0.7 L/min and the device was tested to a capacity of 400 L. The ceramic cartridge was cleaned four times during testing, with the fourth cleaning intentionally reducing the filter diameter to the manufacturer stated minimum size based on the supplied filter gauge. Testing then resumed to demonstrate the reduction capabilities during a pseudo end of filter life condition. The testing conducted in reference 3 was run to 378 L with no information on flowrate stated. Neither testing demonstrated device pathogen reduction capabilities to the manufacturer stated 2,000 L. Due to the testing modifications with respect to reference 1, this evaluation based reduction capabilities on treatment technology. Therefore, this device is assigned one √ for bacteria and cyst reduction (for an explanation of the rating checks click here) based on size exclusion by the ceramic microfilter. Since the device is not designed, and has no mechanism for virus reduction, the device is assigned one X for this pathogen. Additional treatment is required for virus reduction.

Table. Expected Performance Against Microbial Pathogens.

Microbial Pathogen Type	Expected Disinfection Capability	Evaluation Rating	Pathogen Reduction Mechanism
Bacteria	> 6-log	√	size exclusion
Viruses	not effective*	X	none
Giardia cysts	> 3-log	√	size exclusion
Cryptosporidium oocysts	> 3-log	√	size exclusion

* Additional treatment required for virus reduction.

Production Rate and Capacity

Inherent to the production rate and capacity of filtration devices is the quality of the raw water source. The manufacturer stated production capacity of the device is 2000 L at a rate of 1.0 L/min. User effort is stated to be 70-80 strokes/L. This device utilizes a ceramic depth microfilter, which can be cleaned when production rate decreases due to filter clogging. Since cleaning irreversibly decreases the size of the element, the overall capacity of this device will vary widely with raw water turbidity. Illustrating the ability of the similar MSR MiniWork EX device to be cleaned multiple times and continue to process water are results from a study conducted on reducing water turbidity (reference 4). In this study, water with a turbidity of 60-70 NTU was processed and tested for effluent turbidity. The device produced over 300 L of water and underwent 34 cleanings without a reduction in turbidity removal capability and without reducing the ceramic element to its end life diameter. No testing on microbial reduction was conducted during these tests. No data was presented on the capacity of the carbon core within the ceramic element. Since no appreciable pathogen reduction is attributed to the carbon, microbial reduction should remain consistent even if the carbon adsorption capacity is exhausted. No data was presented on the PES microfilter. Since water entering this stage has been processed through the ceramic cartridge it should not be exposed to particulate matter and therefore, is not expected to clog frequently. Capacity of this second stage filter is dependent upon water quality.

Cleaning, Replacement, and End of Life Indicator

This device utilizes a ceramic depth microfilter, which can be cleaned by scrubbing the surface of the filter element to remove accumulated debris. Given the small pore size of the ceramic element, it is expected to clog frequently during use with turbid waters and is therefore designed to be cleaned multiple times throughout its useful life. Supplied with the device is a gauge that is placed over the ceramic element. If the gauge fits around the element then the filter has been cleaned to its capacity and must be replaced. Since the device works solely on size exclusion, as long as the device will process water and the element is not determined to be too thin, stated pathogen reductions should be valid. When the filter begins to clog and pumping difficulty increases a pressure relief valve prohibits the user from over pressurizing the filter and damaging the seals. The second stage PES filter is not capable of being cleaned. Once clogged, this filter must be replaced.

Weight and Size

WaterWorks™ EX	540 grams
Size (height x width x length)	23 cm x 7 cm x 11 cm
Tubing	122 cm

Cost

WaterWorks EX	$140.00
Replacement Marthon EX Ceramic Element	$38.00
Replacement PES Element	$50.00

Device Evaluation

The MSR WaterWorks EX utilizes a ceramic 0.3 µm microfilter with carbon core and a 0.2 µm poly membrane microfilter for the reduction of bacteria and cysts, as well as taste and odor. Data reviewed for the MSR MiniWorks, utilizing similar treatment technology minus the membrane microfilter, showed that it is effective at reducing bacteria and cysts by > 6-log, and > 3-log respectively. Since pathogen reduction is by size exclusion, no virus reduction is expected by this device. Additional treatment is required to fully meet the requirements of reference 1 and ensure adequate reduction of all three classes of microorganism. Since this device utilizes an additional microfilter, pathogen reductions are expected to meet or exceed those of the MiniWorks. Testing was not conducted in accordance with reference 1 since the device was tested to 400 L and not the manufacturer stated 2000 L. Additionally, it is unclear whether the device was tested at the stated production rate of 1 L/min. Due to this, we rate the device as expected to meet the requirements of reference 1, but base this on treatment technology since data specific to this protocol was not received (reference 5). During testing, the device required multiple cleanings. Pathogen reductions remained consistent after cleanings, even when tested at the minimum recommended thickness of the ceramic filter cartridge. This device, like all filters with small pore sizes, is highly affected by turbid (cloudy) waters. A study conducted to determine the ability of the similar MSR MiniWorks EX to filter turbid water showed that when challenged with highly turbid water, the device was able to reduce this turbidity but required frequent cleaning due to particulate build-up. During this testing, the device was cleaned 34 times while processing 300 L. Although this indicates a high maintenance effort, it displays the ability of the device to be cleaned and returned to full performance. This device utilizes no chemicals and requires no wait time prior to water consumption. There is no indicator of process failure. A plastic gauge acts as an end of device useful life indicator. Since during cleaning of the ceramic element the filter reduces size, when the gauge fits around the filter, it must be replaced. No manufacturing information or quality control data was received for this device. This device, like all containing ceramic elements, must not be frozen while wet. Expansion of the water during freezing may crack the element. Additionally, the user should avoid shocking the device due to the brittle nature of the ceramic element and possible fracturing during shock loads. No information was received on the storage life or required storage conditions for this device.

Advantages

- Based on treatment technology and independent data reviewed, this device should be capable of reducing bacteria and cysts to within the requirements of the USEPA Guide Standard and Protocol for Testing Microbiological Water Purifiers (reference 1).
- Second stage microfilter for redundancy in pathogen reduction.
- No wait time prior to water consumption.
- Activated carbon core should reduce taste and odors.
- Field-serviceable.
- End of device useful life indicator.

Disadvantages

- Device is not designed for virus reduction and therefore, unable to fully meet the pathogen reduction requirements of the USEPA Guide Standard and Protocol for Testing Microbiological Water Purifiers (reference 1).
- Additional treatment required.
- Small pore size of filter makes device inherently susceptible to clogging by waters with elevated turbidities.
- Ceramic element fragile to shock loads and freezing.
- No real-time indicator of process failure.

References

1. USEPA, 1989. Guide Standard and Protocol for Testing Microbiological Water Purifiers. *Federal Register*. 54:34067.

2. Independent laboratory results of tests showing bacteria and cyst reduction. 1997. Provided by MSR.

3. Independent laboratory results of tests showing bacteria and cyst reduction. 1996. Provided by MSR.

4. Naval Facilities Engineering Service Center, 1993. Team Water Purifier Test Report. Technical Memorandum TM-2003-AMP.

5. U.S. Army Center for Health Promotion and Preventive Medicine, 2005. *Technical Information Paper; Filtration in the Use of Individual Water Purification Devices*, Aberdeen Proving Ground, MD.